RSR Calibration Comparison Check (CALC)

I. Purpose:

The purpose of this procedure is to describe the steps performed by the RESET team to compare an MFRSR and an ARCS site with a traveling standard MFRSR for a calibration check.

II. Cautions and Hazards:

None.

III. Requirements:

- Calibrated traveling standard MFRSR with datalogger.
- Twelve volt power supply for the comparison MFRSR, if needed.
- 8-pin Macintosh to 25-pin modem (not printer) cable and a 25-pin to DB9 pin (Female or modem) converter or converter cable for PC if BANDAID not used.
- PowerBook or other compatible Apple laptop with BANDAID comparison software, and individual calibration files (e.g., 255.CAL and 255.SOL) for the comparison MFRSR or PC computer with TERM software if BANDAID not used.

IV. Procedure:

A. Steps:

1. Set up comparison standard MFRSR on a separate mount following the setup procedures in the MFRSR instrument manual (**important:** align accurately to true North; see attachment).
2. Turn ON separate comparison MFRSR datalogger.
3. Set up PowerBook to communicate with MFRSR if BANDAID used (if not PC with TERM, can download data from logger).

   Note: This requires a modem data cable and the proper 25- to 9-pin converter cable. Under the Apple control, make Appletalk inactive, change control panel network to remote access only, and change the Remote Access Setup to put the modem on the printer port. Connect cable to the printer port.)

<u>If YESDAS or BANDAID Used</u>

4. Double click on BANDAID 5.15 icon or run YESDAS, click on go from startup, and select terminal emulator. (Baud rates should be 1200, 8 bits, 1 stopbit, no parity. Press return several times fast until you get a hello> prompt.
5. Type "Langley!" password, and opening information to get data from MFRSR (make sure you request all seven channels.)

   Note: In the password “Langley!”, capital “L”, small letters (angley), and exclamation point (!) are necessary.
6. Make certain the time base for this logger is within one (1) second of time base for site MFRSR.
7. Log data to make Xmodem files.

   - In YESDAS select download data from the menus.

   Note: To do this with the PSION or other terminal emulator, select “Xmodem-checksum” ; generate a file named with yyddmmhh.dat and T1 typed.
8. Open Xmodem file from YESDAS or BANDAID and read proper ---.SOL and ---.CAL files from OPTIONS menu to correct for cosine angle and absolute brightness calibration, respectively.
9. Select "Solar and Langley Plots" from the function menu and make plots.
10. Repeat procedure above for second instrument to compare.
11. Examine data for missing channels or other suspicious differences.

12. Copy raw data onto separate disks and send copies along with plots from BANDAID to Mentor.

    Note: Copying raw mfrsr files from ADaM has been made very difficult by ARM decision to name the raw mfrsr files with more characters than most PC ftp software will allow. You need to open a window on ADaM, change directories to get to raw mfrsr data in the data directory, copy the files to a tar file named like rsryymmdd.dat. You can then ftp to ADaM and transfer the file to be sent to the mentor.

IF BANDAID or YESDAS Are Not Used

13. Download data from logger and ftp to TWPPO ftp site**.**

    Note: These files are already compressed and zipping them can cause problems.

B. Getting the MFRSR Configuration

1. Manualy log onto the MFRSR:

   Langley!
   and
   h 0 Irradiance!

   Check status
   S 0

2. Copy status results into configuration file named RSRyymmdd.cfg

   To check the inputs of all 32 channels
   a $FFFF return (then another return after data are displayed)
   Divides the scan rated by this hex number = the slowest scan rate (a 0 scans data very quickly).

   Scanning will have 4 lines with 8 sets of numbers in each line.

   First line first set of numbers is the head temperature in volts.
   1 count = 1 millivolt 2804 counts = 2804 millivolt or 2.8volts.
   For all channels 1 count = 1 millivolt.

   Eight numbers in the first line are as follows:
   1st: 1st line is the head temperature voltage
   2nd: 1st line is the Open detector voltage
   3rd: 1st line is the 415nm filter detector voltage.

4th: 500nm
5th: 615nm
6th: 673nm
7th: 840nm
8th: 1st line is the 940nm filter detector voltage

1 number 2nd line is the board voltage a ratio to the actual power supply voltage.

All remaining channels nothing is connected so could be anything from 0 to 4095 counts they are not used.

3. Add four lines of data to configuration file RSRyymmdd.cfg
4. Type m 1 to find out status of memory and add this to configuration file.

V. References:

1. Harrison, L, J. Michalsky and J. Berndt, 1994: "Automated Multifilter Rotating Shadow-Band Radiometer: An Instrument for Optical Depth and Radiation Measurements," Applied Optics, 33(22), pp. 5118-5125.
2. Yankee, 1994: "Yankee Environmental Systems Optical Calibration Facilities," Rept. Yankee Environmental Systems, Turner Falls, MA, Feb. 1994, p. 16.
3. Yankee, 1995: "MFRSR Instrument Manual."

VI. Attachments:

1. MFRSR NOTES - Peggy Malone (1997).
2. MFRSR Logger Printed Circuit Board.
3. MFRSR Calibration Check Form FM(RSR)-001.
4. Example of Completed Form.
5. Example of MFRSR Configuration File.

0
1
2
3
4

Attachment 1: MFRSR Notes by Peggy Malone

MFRSR NOTES

1. Important that the MFRSR **HEAD** is level, not the crows feet platform. You can use a neat little round leveler made especially for the MFRSR head manufactured by Yankee. You need to move the level around small amounts to get the head level. As you move the level around, you can adjust the leveling screws on the crows feet (the base). You want the bubble a to be in the circle, about the same amount all the way around.

2. Important that the motor angle goes through the sensor. You can use a special tool, called the Band Alignment Tool, for this operation. You put the tool on the motor shaft and make sure the end goes though the sensor (the white thing on the head). The end should be centered on the sensor.

3. Important for the instrument to be aliened towards true north.

   Method: Get the sun dial (aluminum) near or set up by the MFRSR.

   Run one of the DOS based programs like asunpos; asunpos asks you the following questions:

Latitude	=	+35.0517 (for ABQ)
Longitude	=	-106.5358 (for ABQ)
Year	=	1997 (or current year)
Zone	=	+6 for DST for ABQ or +7 for normal Time to add to get WWV or GMT call 303-499-7111 to get GMT
Day of the year	=	EX: 167 = 6/16/97
Current time	=	If you use DST for the zone use DST here also , even though it says to use standard time. Use dots when giving the time like 9.30.30 NOT 9:30:30.

   This will give you the azimuth. You want to fool with the program enough to get azimuths like 85 or 120 (basically degrees that end with 0 or 5). You can get real close by keep adjusting the time. If you got 122.4609, you would try another time with the program. You could subtract or add minutes/seconds to see the different results. You want to get 120 or 125 degrees (for this example). The sundial is in 5 degree increments, so degrees that end in 0 or 5 make the alignment more accurate.

When the time you selected for your azimuth approaches, go over to the MFRSR. Set up the sundial. You are looking for the shadow of the stand to hit one of the marks on the sun dial. If it is morning, then add 180 degrees to your azimuth number (the place where the shadow will fall). If it is the afternoon, the subtract 180 degrees from the azimuth number. At the prescribed time, the shadow of the stand should be at the degrees number you figured out. If it is not, then move the stand to get the shadow correct. You can check this several times.

4. It is important that the band motor is set to the correct latitude. Use can use a protractor to perform this task. For ABQ the band motor should be set around 35 degrees.

5. Using the Band Alignment Tool you used to get the sensor in line with the band motor, you can get the shadowband in the right shape. The shadowband should fit the back of tool. Sometimes the shadowband can get off to one side or the other.

6. Once the MFRSR is working and the shadowband is rotating you need to check to see if the shadowband itself is adjusted. The shadowband goes over the sensor and shades the sensor once every rotation. There is a small screw in the rod that holds the shadow band. A .05" allen wrench will perfectly adjust the screw. A little goes a long way here. So you watch the shadowband a few times and decide which way to move the band if necessary. You move the band (yes, while the MFRSR is running). Now watch the band for SEVERAL rotations. You'll go crazy adjusting the band every rotation, due to the fact the stepper motor adjusts itself every 800 steps. After several rotations, you can adjust the band again.

7. At a bench, you can adjust the band motor for the correct latitude, make sure the shadow band is the correct shape, and make sure the sensor is in line with the band motor. Then you can take the stand outside and to the rest of the adjustments.

8. To setup the MFRSR, use a terminal emulation program.
(**Note:** It is best at this point to use the terminal emulator under the function menu in DOSBAND, other emulators (such as the PSION or TERM on a PC) work, but do not download the datalogger files.

9. Connect to the microprocessor port either in ARCS2 or the microprocessor itself.

Settings:

Baud Rate:	19200 or less if line is bad
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None (No Xon/Xoff stuff)

Connector: COM1
Receive
files with: Xmodem
When setup is complete, hold down the return key for several seconds. You will get a Hello: prompt. Type in the password ***Langley!.*** Then you will get the PROM version and the !> prompt as shown below.

Hello:
Hello:

PROM YESR7N, L. Harrison, 03/97.
!>

One of the commands you can type here is 's 0'. This is the status command. The fields are described below. With this command you can check to make sure the MFRSR is setup correctly.

```
!>s 0
 $BFD8  $C0CA 7Y [7]   35.0463   106.5399
16:41:43   06-16-1997  35596.69563 (1997)
$20 $00000101 $00000000 $000000                    <<< Flags - see manual
   20     20
  117      3
```

Field	Comment
$BFD8	YESDAS system ID
$C0CA	MFR head ID
7Y	PROM version
[7]	Number of channels
-2.069	Latitude for Manus
-147.425	Longitude
16:41:43	Time
06-16-1997	Date
35596.69563	Time since 1/1/1900
(1997)	Year
20	Sampling interval in seconds
20	Averaging interval in seconds
117	Bytes in memory
3	Records in memory

To set the flags or look/read memory you need to be superuser. The "h 0" command takes care of this, plus the superuser password.

PROM YESR7N, L. Harrison, 03/97.

!>h 0 Irradiance!
To setup the MFRSR, perform the following commands:

!> I $20 $00000101 0 20 1	<<<set flags - see manual
!> N 7	<<<Set number of active channels to 7
!> U 0 yyyy mm dd hh mmss	<<<Set Date and Time
!> L 0 -2.069 –147.425	<<<Set latitude/longitude

Note: If system is running, you need to type "g 0" before changing date and time. It is important to use the I $20 $00000101 0 20 1 in order for the .cal and .sol files to work correctly on the data.

Other Commands:

Command	Comment
U	Update system clock. See manual (p. 4-29) for details.
m 0	See how much data is on the memory card
m 1	Move data from the local buffer to the memory card.
T1	Read the memory card. Need to use Receive Binary command to get the data. Don't use checksums for the transfer and use Xmodem checksum protocol. (This works well in DOSBAND but does not seem to work in TERM.) **Note:** With psion must be in protocol "Xmodem-checksum"; also null modem.
g 0	Stop the processing
g 1	Start the processing (g 0 and then g 1 clears the memory card)

Samples:
!>m 0
MEMCARD SIZE, USED = 1024 kB, 289.6396 kB
!>m 1
READY
!>m 0
MEMCARD SIZE, USED = 1024 kB, 289.7539 kB
!>

9. The MFRSR has 2 heaters in it to keep the head at a constant temperature. If the temperature is not around 40 degrees then you have a problem with the unit.

10. The MFRSR gives out raw data which is binary and consists of counts from 0-4096. Normally the data goes into a program called CALLANG (for UNIX only and made by ASRC). The PC equivalent is DOSBAND. The MAC equivalent is BANDAID.

You can view the raw data. You can apply a Solar Info file (file contains angle corrections) to the data, so you can view the angle corrected data. Next you can apply a Calibration file to view calibrated data. This file has the calibrated coefficients in it. The calibrated data is in the form watts/meter squared/nano meter.

Process:

Get data to CALLANG
View raw data if desired
Apply Solar Info file and view data in desired
Apply Calibration file and view data (must have solar info file applied before hand)

11. SZA - solar zenith angle
    The angle between the sun when is straight up in the sky and the position of sun currently. The Solar Info file uses the cos(SZA).

    direct = total - diffused / (cos(SZA))

12. DOSBAND - the PC version of CALLANG

Data files:

Column 1: Time since 1/1/1900 in GMT
Column 2: cos (SZA)
Column 3: Counts - the data should be 23 columns of data. The counts should be in the high 2900s. 7 columns for total radiation; 7 columns of diffused; 7 columns for direct; 1 column logger board voltage; 1 column for head temperature

13. To use DOSBAND:

    In the DOSBAND directory, start DOSBAND. DOSBAND is an old DOS-based program and the mouse is not supported. Use the ALT key to move around the menus. For example, ALT+F opens the FILE menu.

    Steps:

    - Open your raw file.
    - Under Function->Day Plot you can view the data.
    - Keys: Left arrow key views the PM data and the right arrow key views the AM data.
      Up arrow views the next channel. ESC exits the plotting.
      For angle data use Function->Solor Angle and for calibrated data use Function->Calibrated. Both ask you for the associated input files.

14. **Steps In Order**:
    Do the bench steps: adjust the angle of the motor (Note 4), make sure the motor angle goes though the sensor (Note 2), and adjust the shape of the shadowband (Note 5).

    Outside setup the MFRSR and align it to true north (Note 3), then level the head (Note 1). Next get the microprocessor working (Note 8) and then as the last thing, adjust shadowband rotation (Note 6).

15. MFRSR stuff on ADaM:
    - .xttyrc in /files0/ADaM/config/mfrsr
    - xtty is in /files0/ADaM - reads the data
    - .xttyrc tells xtty how to read the data
    - xtty can configure the MFRSR micro processor
    - xtty also checks the microprocessor configuration and complains if the configuration is different
    - see the data in /files1/ADaM/data_hold/raw/mfrsr
    - to run xtty by hand use the following command:

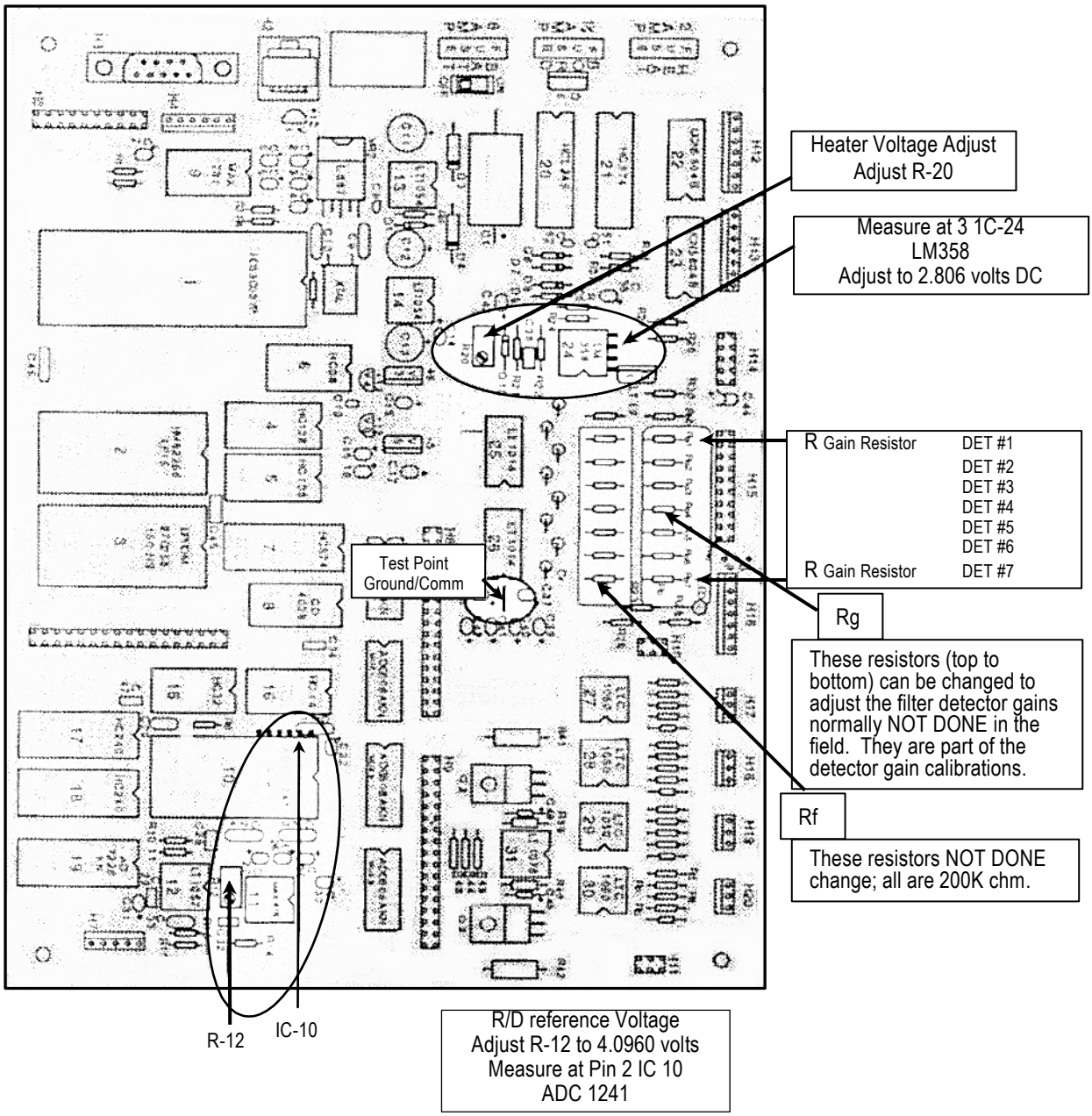
      in /files0/ADaM/config/mfrsr

    xtty -o ../data_hold/raw/mfrsr -y ../../data_hold/logs/mfrsr -v 3 tty /dev/cua/19

    where -o is the output file location
    -y is the log file location
    -v 3 is the level of verbose (3 is the most wordy)
    /dev/cua/19 is the serial port to work with

Attachment 2: MFRSR Logger Printed Circuit Board

MFRSR LOGGER PRINTED CIRCUIT BOARD
R/D Reference Voltage
Heater Voltage
Filter Detector Logger Board Gain Resistors
ADC Reference Voltage Adjustment
Heater Voltage Adjustment



Attachment 3: MFRSR Calibration Check Form FM(RSR)-001

ARCS MFRSR Calibration Check Form

I. Calibration information

This is a (check which):	Calibration	Calibration Check	Field Calibration
		X	

Date:	GMT Begin Time:	GMT End Time:	ARCS #

Instrument / System:	TWP OMS Part Number(s):	TWP OMS Serial Number(s):
MFRSR SKYRAD	MFR7-Head/MFRSR-Logger Board	

Location (eg. PNNL, Manus):	Participant(s):	Issued by:	Signature(s):

Reference Instrument(s):	TWP OMS Part Number(s):	TWP OMS Serial Number(s):
MFRSR Comparison Stand	MFR7-Head/MFRSR-Logger Board	

Current Configuration File Name: (from status command S 0)	New Configuration File Name:

What is local time for solar noon? (use ARM calculator or other technique)		Have the MFRSR levels been checked (yes/No)?	
Have the MFRSRs been aligned at solar noon (Yes/No)?			

II. Initial Values

Sensor/Element:	optical depth @415 nm	optical depth @500 nm	optical depth @615 nm	optical depth @670 nm	optical depth @867 nm	optical depth @940 nm
MFRSR SKYRAD						
MFRSR Comparison						

Sensor/Element:	Io (W/m2/nm) @415 nm	Io (W/m2/nm) @500 nm	Io (W/m2/nm) @615 nm	Io (W/m2/nm) @670 nm	Io (W/m2/nm) @867 nm	Io (W/m2/nm) @940 nm
MFRSR SKYRAD						
MFRSR Comparison						

III. Final Values

UNCHANGED: ☐ CHANGED: ☐

Sensor/Element:	optical depth @415 nm	optical depth @500 nm	optical depth @615 nm	optical depth @670 nm	optical depth @867 nm	optical depth @940 nm
MFRSR SKYRAD						
MFRSR Comparison						

Sensor/Element:	Io (W/m2/nm) @415 nm	Io (W/m2/nm) @500 nm	Io (W/m2/nm) @615 nm	Io (W/m2/nm) @670 nm	Io (W/m2/nm) @867 nm	Io (W/m2/nm) @940 nm
MFRSR SKYRAD						
MFRSR Comparison						

IV Statistics (if applicable)

No. of Samples:	Std. Dev.	CF Range %	Uncertanty %

V. Calilbration Change(if applicable)

Sensor or Parameter	Sensor Serial No.	Internal Resistance (Ohms)	Original Sensitivity (Volts/Unit)	Offset	Quadratic
	Old	Old	Old	Old	Old
	New	New	New	New	New
MFRSR SKYRAD					

Document(s) Referenced:	Document(s) Updated:
PRO(RSR)-004.003	

PROBLEMS:

NOTES:

Attachment 4: Example of Completed Form

ARCS MFRSR Calibration Check Form

I. Calibration information

This is a (check which):	Calibration	Calibration Check	Field Calibration
		X	

Date:	GMT Begin Time:	GMT End Time:	ARCS #
7/6/00	0:00	2:00	2

Instrument / System:	TWP OMS Part Number(s):	TWP OMS Serial Number(s):
MFRSR SKYRAD	MFR7-Head/MFRSR-Logger Board	Head 240

Location (eg. PNNL, Manus):	Participant(s):	Issued by:	Signature(s):
Nauru	Porch		

Reference Instrument(s):	TWP OMS Part Number(s):	TWP OMS Serial Number(s):
MFRSR Comparison Stand	MFR7-Head/MFRSR-Logger Board	

Current Configuration File Name: (from status command S 0)	New Configuration File Name:
RSR00626.cfg	

What is local time for solar noon? (use ARM calculator or other technique)	12:56	Have the MFRSR levels been checked (yes/No)?	yes
Have the MFRSRs been aligned at solar noon (Yes/No)?	yes		

II. Initial Values

Date Local	6/27/00

Sensor/Element:	optical depth @415 nm	optical depth @500 nm	optical depth @615 nm	optical depth @670 nm	optical depth @867 nm
MFRSR SKYRAD	0.339 AM 0.351 PM	0.181 AM 0.203 PM	0.114 AM 0.131 PM	0.079 AM 0.083 PM	0.041 AM 0.054 PM
MFRSR Comparison					

Sensor/Element:	Io (W/m2/nm) @415 nm	Io (W/m2/nm) @500 nm	Io (W/m2/nm) @615 nm	Io (W/m2/nm) @670 nm	Io (W/m2/nm) @867 nm
MFRSR SKYRAD	1.62 AM 1.70 PM	1.76 AM 1.90 PM	1.59 AM 1.68 PM	1.52 AM 1.54 PM	0.93 AM 0.93 PM
MFRSR Comparison					
Theoretical Io	1.7	1.9	1.7	1.55	0.95

III. Final Values

UNCHANGED: ☐ CHANGED: ☐

Sensor/Element:	optical depth @415 nm	optical depth @500 nm	optical depth @615 nm	optical depth @670 nm	optical depth @867 nm
MFRSR SKYRAD					
MFRSR Comparison					

Sensor/Element:	Io (W/m2/nm) @415 nm	Io (W/m2/nm) @500 nm	Io (W/m2/nm) @615 nm	Io (W/m2/nm) @670 nm	Io (W/m2/nm) @867 nm
MFRSR SKYRAD					
MFRSR Comparison					

IV Statistics(if applicable)

No. of Samples:	Std. Dev.	CF Range %	Uncertanty %

V. Calilbration Change(if applicable)

Sensor or Parameter	Sensor Serial No.	Internal Resistance (Ohms)	Original Sensitivity (Volts/Unit)	Offset	Quadratic
	Old	Old	Old	Old	Old
	New	New	New	New	New
MFRSR SKYRAD					

Document(s) Referenced:	Document(s) Updated:
PRO(RSR)-004.003	

PROBLEMS:
Shortening names on ADaM caused a problem as the name was split on two lines and highlighting the whole name gave an error (so copied the name segment one one line entered it and selected the remaining part of the name for the CP command and a small name like rsr0705.dat, then I converted .dat files to .xmd after ftp'ing them. Tried to remember to delete .dat file from ADaM afterward.

NOTES:

Attachment 5: Example of MFRSR Configuration File

$B3F6 $6D0E 7Y [7] -0.5163 -166.9152
04:35:59 06-26-2000 36702.19165 (0)
$20 $00000101 $00000000 $000000
20 20
156 4

!>